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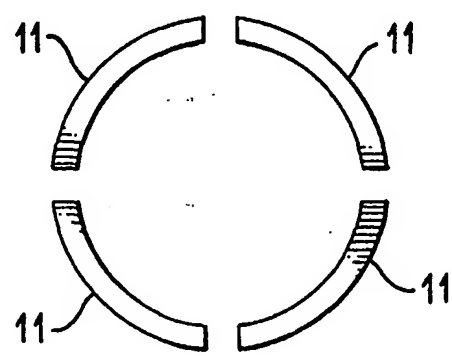
(54) Title: HOLLOW POLYMER FIBER NONWOVEN WEB MATERIAL

(57) Abstract

A personal care absorbent article constructed of a hollow polymer fiber nonwoven material produced from a plurality of hollow polymer fibers and having a basis weight in the range of about 8 gsm to about 200 gsm. The hollow polymer fibers of this nonwoven web material have an outside diameter in the range of about 7 microns to about 50 microns. The hollow polymer fibers of this invention in accordance with one embodiment are made from a metallocene polypropylene resin.



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HOLLOW POLYMER FIBER NONWOVEN WEB MATERIAL

FIELD OF THE INVENTION

This invention relates to nonwoven materials and nonwoven laminates, including nonwoven/film laminates and more particularly to nonwoven materials suitable for use in personal care absorbent articles such as diapers, incontinence garments, training pants, feminine care products such as sanitary napkins and pads, and the like. More particularly, this invention relates to nonwoven materials formed of hollow filaments and/or hollow fibers useful in personal care absorbent articles.

DESCRIPTION OF PRIOR ART

Nonwoven fabrics and laminates comprising nonwoven fabrics are widely used as components of absorbent articles such as disposable diapers, feminine hygiene products including sanitary pads and tampons, incontinence garments, disposable medical garments and the like, and much effort has been made to improve the effectiveness and functionality of these articles. These articles generally include a liquid absorbent material backed by a liquid-impervious barrier sheet. To enhance the sense of comfort, the absorbent material has a facing of a material which masks at least the body-facing surface of the product. The purpose of this cover or liner material is to help structurally contain the absorbent material and to protect the wearer from continuous direct contact with moisture from previously wetted absorbent material. The cover material is typically a relatively low basis weight nonwoven fabric. Improved product performance has been obtained in these products through the incorporation of a surge management material disposed between this cover material and the absorbent material. (See U.S. Patent 5,429,629.) The surge

management material is made from a relatively high basis weight, low density, that is thick, nonwoven web material. The cover material must, therefore, be permeable to liquids on the side of the product that is placed against the body, actively promoting the immediate transfer of each liquid application or insult through the surge management material and into the absorbent pad. It is also necessary that the surge management material initially hold the liquid passed through the cover material and then give up said liquid to the absorbent material.

In order to satisfy these requirements, it is necessary that the surfaces of the cover material and surge management material or the surface of the fibers forming said nonwoven fabrics, be first wetted by the liquid. Wettability of nonwoven webs or fibers thereof is known to be achievable by treating the surface thereof with surfactants. See, for example, U.S. Patent 4,413,032 to Hartmann et al. and U.S. Patent 5,045,387 to Schmalz. Alternative methods of imparting wettability to such materials are taught, for example, by U.S. Patent 5,456,982 to Hansen et al. in which a bicomponent fiber is provided with permanent hydrophilic surface properties by incorporating a surface active agent into the sheath component and optionally by including a hydrophilic polymer or copolymer in the sheath component. See, also, U.S. Patent 5,582,904 to Harrington which teaches the incorporation into a polyolefin-containing cast or spin-melt composition for production of nonwoven materials a modifier composition comprising at least one M,M-polyalkoxylated 10-22 carbon fatty acid amine, inclusive of amines having 12-20 carbon and preferably 18 carbon linear straight chain moiety corresponding to that found in stearic or oleic acid, and up to about 60%, including 0.1%-45% by weight of a modifier composition, of a primary or secondary 10-22 carbon fatty acid amide, such as stearamide.

One characteristic of a liner material which affects the fluid intake characteristics of the material is the amount of void volume within the material. In particular, by increasing the amount of void volume, the fluid intake characteristics, that is the ability of the liner material to initiate fluid intake, is improved. For nonwoven liners, void volume, or pore size, can be typically increased by increasing the fiber denier of fibers making up the liner material. However, increasing fiber denier could result in an undesirable decrease in fiber softness.

For surge management, it has been found that an effective material is characterized by one or more of the following qualities: (a) a resilient structure having a selected basis weight; (b) an appropriate amount of total fiber surface area within the internal structure of the material; (c) a balance of fiber surface areas which are wettable and non-wettable; and (d) an appropriate distribution of the fibers within the volumetric space defined by the surge management material. More particularly, the surge management material incorporates distinctive parameters which help characterize the liquid capillarity and other features thereof, which parameters include the total amount of fiber surface area per standard unit of material; the amount of wettable surface area of such fibers per standard unit of material; a total wettable surface area multiplied by density parameter; and a total nonwettable surface area multiplied by density parameter.

One issue associated with the use of nonwoven laminate fabrics in personal care absorbent articles is the ability to provide a combination of contradictory properties, such as pleasing aesthetics, (softness, flexibility, and the like) and strength and abrasion resistance in a single fabric. For example, spunbond webs used in laminate products are typically formed of 100% polypropylene filaments to reinforce and protect inner layers from

excessive stresses and potential damage during use. The resulting laminate can be more durable and have improved appearance. This can also minimize contamination of sterile surfaces in medical applications by preventing loose fibers from contaminating sterile environments.

SUMMARY OF THE INVENTION

It is one object of this invention to provide a nonwoven fabric and laminate for use in personal care absorbent articles such as disposable diapers, feminine hygiene products, incontinence garments, disposable medical garments and the like.

It is one object of this invention to provide a liner for use in personal care absorbent articles such as sanitary napkins, catamenial pads, incontinence garments, disposable diapers or training pants for infant care, adult care or child care, and the like.

It is another object of this invention to provide a liner material for personal care absorbent articles which is capable of initiating fluid intake as a result of increased void volume compared to conventional liner materials while reducing the amount of polymer required to produce the fibers comprising the liner material compared to conventional liner materials having comparable void volumes.

It is yet another object of this invention to provide a surge management material which provides a desired fiber surface area per standard unit of material using less polymer than comparable surge management materials.

These and other objects of this invention are addressed by a personal care absorbent article comprising a hollow polymer fiber nonwoven material having a basis weight in the range of about 8grams per square meter (gsm) to about 200 gsm, which hollow polymer fibers have an outside diameter in the range of about 7 microns to about 50 microns.

As used herein, the term "hollow" is a volumetric value of the fiber, referring to the volume occupied by the lumen of the fiber. "Hollow percentage" refers to the portion of the total volume of a fiber occupied by a lumen. The lumen of the hollow polymer fibers in accordance with this invention comprises in the range of about 10% to about 60% by volume of the hollow polymer fibers, more preferably about 20% to about 60% by volume of the hollow polymer fibers, and most preferably about 30% to about 60% by volume of said hollow polymer fibers. In accordance with one particularly preferred embodiment of this invention, the hollow polymer fiber nonwoven web material is made from hollow polymer fibers comprising a metallocene polypropylene polymer. Hollow polymer fibers comprising a metallocene polypropylene polymer in accordance with this invention have a hollow percentage in the range of about 30 to 50% higher than hollow fibers made with standard polypropylene. In accordance with one particularly preferred embodiment of this invention, the hollow polymer fiber nonwoven material is a spunbond.

Across a range of basis weights, hollow spunbond nonwoven materials are stronger than conventional solid round fiber spunbond nonwoven materials by at least about 30% with less elongation. As measured by cup crush, hollow spunbond material may not be as soft as solid round fiber spunbond in some cases, but it is typically more porous and has a higher level of bulk. At a comparable level of strength to a 17 gsm basis weight solid round fiber spunbond, hollow fiber spunbond can be made at a 12 gsm basis weight. At these weights, hollow fiber spunbond material is softer and more porous than solid round fiber spunbond material. In addition, the higher bulk translates to increased void volume for improved fluid management, particularly suitable for liner material applications. The same

low density/high capacity attributes of the hollow fiber spunbond material are also important for surge applications.

Hollow fiber materials have improved formation over solid round fiber materials. Hollow fiber structures are naturally more efficient structures with respect to providing surface area and fiber strength than solid round fiber structures per unit of mass. Hollow fiber materials have a reduced mass compared to materials made from conventional solid round fibers of equal diameter. Thus hollow fiber fabrics can be provided having additional fibers per unit area at an equivalent basis weight relative to fabrics comprising conventional solid fiber materials, or conversely, fabrics having a lower basis weight without lowering the number of fibers or filaments. This can improve the opacity, strength and/or barrier properties of the fabrics without unduly increasing basis weight. This can also improve resistance to bleed through of adhesives and improved superabsorbent particle containment and strikethrough/rewet for hygiene applications due to the increased number of filaments and/or fibers for a given basis weight.

In addition to increased strength, reduced elongation of the hollow fibers to break at peak load translates into less material stretching and necking during product conversion compared to nonwoven materials made with corresponding diameter solid round fibers. In addition, at equivalent basis weights, hollow fiber spunbond materials show very little cross directional deformation as compared to conventional solid round fiber spunbond materials made from fibers of equivalent fiber diameter. This attribute provides significant benefits where material deformation in the cross direction produces conversion difficulties, i.e. diaper conversion, spunbond/film lamination, etc.

As previously stated, hollow fiber spunbond materials in accordance with this invention can be substituted for conventional solid round fiber spunbond materials at the existing basis weight to provide improved functionality or at a reduced basis weight with substantially equivalent functionality. A number of potential applications exist under either scenario. For example, hollow fiber spunbond materials can provide improved coverage and opacity, enhance barrier properties and improve strength for applications such as spunbond/meltblown/spunbond (SMS) materials for professional health care. In addition, crimped through-air-bonded bicomponent hollow fibers can be used for high performance surge materials. At lower basis weights, hollow fiber materials being as strong, more porous and softer than solid round fiber materials have value as liners, outer covers incorporating fibrous layers or low cost surge materials for personal care absorbent articles.

Although the invention claimed herein is described generally with respect to liner materials for use in personal care absorbent articles, the nonwoven materials constructed of hollow polymer fibers as claimed herein may be used in other portions of such personal care absorbent articles, for example as a surge material, and such other applications are considered to be within the scope of the claims. In addition, the nonwoven materials constructed of hollow polymer fibers as claimed herein may be used in a variety of personal care absorbent articles such as disposable diapers, feminine hygiene products, incontinence garments, disposable medical garments and the like and such applications are considered to be within the scope of the claims.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other objects and features of this invention will be better understood from the following detailed description taken in conjunction with the drawings wherein:

Figs. 1A and 1B show schematically representative spinneret capillary arrangements for spinning peripherally round filaments having a single concentric longitudinal void (lumen) where Fig. 1A shows a vertical cross-section through the spinneret and Fig. 1B shows a corresponding view of the spinneret face where the molten filament streams emerge for the capillary arrangement shown in Fig. 1A.

DEFINITIONS

As used herein, the term "nonwoven web" or "nonwoven material" means a material having a structure of individual fibers or threads which are interlaid, but not in an identifiable manner, as in a knitted fabric. Nonwoven materials or webs have been formed from many processes such as, for example, spunbonding processes, meltblowing processes, and bonded carded web processes. The basis weight of nonwoven fabrics is usually expressed in grams per square meter (gsm) and the fiber diameters are usually expressed in microns.

The term "machine direction" or "MD" as used herein refers to the direction of travel of the forming surface onto which fibers are deposited during formation of a nonwoven web.

The term "cross-machine direction" or "CD" as used herein refers to the direction perpendicular to the machine direction.

As used herein, the term "spunbond fibers" refers to small diameter fibers which are formed by extruding molten thermoplastic material as filaments from a plurality of fine, usually circular capillaries of a spinneret, with the diameter of the extruded filaments then being rapidly reduced as by, for example, in U.S. Patent 4,340,563 to Appel et al., U.S. Patent 3,692,618 to Dorschner et al., U.S. Patent 3,802,817 to Matsuki et al., U.S. Patent 3,338,992 and 3,341,394 to Kinney, U.S. Patent 3,502,763 to Hartmann, and U.S. Patent 3,542,615 to Dobo et al. Spunbond fibers are generally not tacky when they are deposited onto a collecting surface. Spunbond fibers are generally continuous and have average diameters (from a sample of at least 10) larger than 7 microns, more particularly, between about 10 and 50 microns. The fibers may also have shapes such as those described in U.S. Patent 5,277,976 to Hogle et al., U.S. Patent 5,466,410 to Hills, and U.S. Patent 5,069,970 and U.S. Patent 5,057,368 to Largman et al., which describe hybrids with unconventional shapes. A nonwoven web of spunbond fibers produced by melt spinning is referred to as a "spunbond".

As used herein, the term "polymer" generally includes, but is not limited to, homopolymers, copolymers, such as for example, block, graft, random and alternating copolymers, terpolymers, etc., and blends and modifications thereof. In addition, unless otherwise specifically limited, the term "polymer" also includes all possible geometric configurations of the molecule. These configurations include, but are not limited to, isotactic, atactic, syndiotactic and random symmetries.

As used herein, the term "monocomponent" fiber refers to a fiber formed from one or more extruders using only one polymer. This is not meant to exclude fibers formed from one polymer to which small amounts of additives have been added for coloration, anti-

static properties, lubrication, hydrophilicity, etc. These additives, for example titanium dioxide for coloration, are generally present in an amount less than about 5 weight percent and more typically about 2 weight percent.

As used herein, the term "bicomponent fibers" refers to fibers which have been formed from at least two different polymers extruded from separate extruders but spun together to form one fiber. Bicomponent fibers are also sometimes referred to as conjugate fibers or multicomponent fibers. The polymers are arranged in substantially constantly positioned distinct zones across the cross-section of the bicomponent fibers and extend continuously along the length of the bicomponent fibers. The configuration of such a bicomponent fiber may be, for example, a sheath/core arrangement wherein one polymer is surrounded by another, or may be a side-by-side arrangement, a pie arrangement, or an "islands-in-the-sea" arrangement. Bicomponent fibers are taught by U.S. Patent 5,108,820 to Kaneko et al., U.S. Patent 4,795,668 to Krueger, et al., U.S. Patent 5,540,992 to Marcher et al., and U.S. Patent 5,336,552 to Strack et al. Bicomponent fibers are also taught by U.S. Patent 5,382,400 to Pike et al., and may be used to produce crimp in the fibers by using the differential rates of expansion and contraction of the two (or more) polymers. For two component fibers, the polymers are desirably present in ratios of 75/25 to 25/75 or any other desired ratio and, as an example, may be 50/50. Fibers formed of two or more segments of the same polymer, such as a polypropylene (PP)/PP fiber, as discussed elsewhere in this disclosure, are considered to be monocomponent fibers.

As used herein, "thermal point bonding" involves passing a fabric or web of fibers to be bonded between a heated calender roll and an anvil roll. The calender roll is usually, though not always, patterned in some way so that the entire fabric is not bonded

across its entire surface. As a result, various patterns for calender rolls have been developed for functional as well as aesthetic reasons. Typically, the percent bonding area varies from around 5% to around 30% of the area of the fabric laminate web. As is well known in the art, the spot bonding holds the laminate layers together as well as imparts integrity to each individual layer by bonding filaments and/or fibers within each layer. Exemplary bond patterns are taught by U.S. Patent 3,855,046 to Hansen et al., U.S. Patent 5,620779 to Levy et al., and U.S. Design Patent 356,688 to Uitenbroek et al., all of which are incorporated herein by reference.

As used herein, "through-air bonding" ("TAB") is a process of bonding a nonwoven bicomponent fiber web in which air sufficiently hot to melt one of the polymers in the fibers of the web is forced through the web. The air velocity is between 100 and 500 feet per minute and the dwell time may be as long as 6 seconds. The melting and resolidification of the polymer provides the bonding. TAB has relatively restricted variability and since TAB requires the melting of at least one component to accomplish bonding, it is most effective when applied to webs with two components like conjugate fibers or those which include an adhesive. In the through-air bonder, air having a temperature above the melting temperature of one component and below the melting temperature of another component is directed from a surrounding hood, through the web, and into a perforated roller supporting the web. Alternatively, the through-air bonder may be a flat arrangement wherein the air is directed vertically downward onto the web. The operating conditions of the two configurations are similar, the primary difference being the geometry of the web during bonding. The hot air melts the lower melting polymer component and thereby forms bonds between the filaments to integrate the web.

DESCRIPTION OF PREFERRED EMBODIMENTS

The material of this invention is a hollow polymer fiber nonwoven web material having a basis weight in the range of about 8 gsm to about 200 gsm, the hollow polymer fibers of which have an outside diameter in the range of about 7 microns to about 50 microns, more preferably about 10 to about 30 microns. In accordance with one particularly preferred embodiment, the basis weight of the hollow polymer fiber nonwoven web material is in a range of about 10 gsm to about 30 gsm. The material of this invention is suitable for use in personal care absorbent articles such as diapers, training pants, adult incontinence garments, feminine care products, disposable medical garments and the like. In accordance with a particularly preferred embodiment of this invention, the material is used as a liner for such personal care absorbent articles.

The hollow fibers suitable for use in the material of this invention are formed using conventional meltspinning technologies, and preferably a spunbond process. Many of the aesthetic and physical attributes of the material formed by such hollow fibers are essentially the same as a solid fiber having an equivalent diameter. However, the material of this invention has a lower mass and basis weight proportionate to the hollow center compared to materials formed by solid fibers. Polymers suitable for use in the manufacture of such hollow fibers include any polymer or polymers suitable for producing fibers, but are not limited to polymers currently used in connection with personal care absorbent articles. Such polymers include, but are not limited to, metallocene polymers, polypropylene (PP), polyethylene, nylon, polyester, and combinations thereof. Preferred polymers are those polymers produced using metallocene catalysis. Particularly preferred is metallocene polypropylene (mPP).

In order to produce hollow fibers for the hollow polymer fiber nonwoven material of this invention, a standard unitary spinpack is used in conjunction with a hollow spinneret (Figs. 1A and 1B). Each spinneret hole 10 (Fig. 1A) consists of at least two equally spaced slotted curved segments 11 (Fig. 1B). Each spinneret hole preferably consists of, but is not limited to, two, three or four equally spaced slotted curved segments. Polymer is extruded through the slotted curved segments at a desired throughput rate. As the polymer leaves each slotted curved segment, it rejoins the nearest polymer slotted curved segment, but does not come together in the center, leaving a hollow core (lumen). The resulting fiber has the same relative aesthetic appearance as a solid fiber of the same diameter, but has reduced mass.

In accordance with one preferred embodiment of this invention, the hollow polymer fibers are monocomponent or bicomponent fibers comprising at least two segments. An example of a monocomponent hollow polymer fiber suitable for use in nonwoven materials in accordance with one embodiment of this invention is a metallocene polypropylene(mPP)/mPP fiber. Examples of bicomponent hollow fibers suitable for use in nonwoven materials in accordance with this invention, which hollow fibers typically have a larger hollow portion than fibers produced with Zeigler-Natta polypropylene resins, include side-by-side PP/mPP, PP/propylene ethylene copolymers (e.g. 6D43, a copolymer available from Union Carbide which comprises 3% ethylene) and PP/PP plus propylene butylene copolymer (e.g. DS4D05, a polypropylene 14% butylene copolymer available from Shell Chemical Company). In order to produce substantially perfect segmented shaped bicomponent fibers, the polymer melt temperatures must be adjusted during spinning to achieve a viscosity match of both polymers.

Polymers produced using metallocene catalysts have a narrow molecular weight distribution. "Narrow molecular weight distribution polymer" refers to a polymer that exhibits a molecular weight distribution of less than about 3.5. As is known in the art, the molecular weight distribution of a polymer is the ratio of the weight average molecular weight of the polymer to the number average molecular weight of the polymer. Methods of determining molecular weight distribution are described in the Encyclopedia of Polymer Science and Engineering, Volume 3, Pages 299-300 (1985). Examples of narrow molecular weight distribution polyolefins include the metallocene-catalyzed polyolefins, the single-site catalyzed polyolefins, and the constrained geometry-catalyzed polyolefins described above. As is known in the art, the metallocene-catalyzed polyolefins and the constrained geometry-catalyzed polyolefins are sometimes referred to as types of single-site catalyzed polymers. Polydispersities (M_w/M_n) of below 3.5 and even below 2 are possible for metallocene produced polymers. Metallocene produced polymers having a polydispersity below about 3.0 are desirable and below about 2.5 even more desirable. These polymers also have a narrow short chain branching distribution when compared to otherwise similar Ziegler-Natta produced polymers.

Metallocene catalysts include bis(n-butylcyclopentadienyl) titanium dichloride, bis(n-butylcyclopentadienyl)zirconium dichloride, bis(cyclopentadienyl)-scandium chloride, bis(indenyl)zirconium dichloride, bis(methylcyclopentadienyl)-titanium dichloride, bis(methylcyclopentadienyl)zirconium dichloride, cobaltocene, cyclopentadienyltitanium trichloride, ferrocene, hafnocene dichloride, isopropyl-(cyclopentadienyl$_1$-1-flourenyl)zirconium dichloride, molybdocene dichloride, nickelocene, niobocene dichloride, ruthenocene, titanocene dichloride, zirconocene chloride hydride, zirconocene dichloride,

among others. A more exhaustive list of such compounds is included in U.S. Patent 5,374,696 to Rosen et al. and assigned to the Dow Chemical Company. Such compounds are also discussed in U.S. Patent 5,064,802 to Stevens et al. and also assigned to Dow.

The metallocene process, and particularly the catalysts and catalyst support systems are the subject of a number of patents. U.S. Patent 4,542,199 to Kaminsky et al. describes a procedure wherein a metallocene catalyst of the general formula (cyclopentadienyl)2MeRHal wherein Me is a transition metal, Hal is a halogen and R is cyclopentadienyl or a C1 to C6 alkyl radical or a halogen, is used to form polyethylene. U.S. Patent 5,189,192 to LaPointe et al. and assigned to Dow Chemical describes a process for preparing addition polymerization catalysts via metal center oxidation. U.S. Patent 5,352,749 to Exxon Chemical Patents, Inc. describes a method for polymerizing monomers in fluidized beds. U.S. Patent 5,349,100 describes chiral metallocene compounds and preparation thereof by creation of a chiral center by enantioselective hydride transfer.

Co-catalysts are materials such as methylaluminoxane (MAO) which is the most common, other alkylaluminums and boron containing compounds like tris(pentafluorophenyl)boron, lithium tetrakis(pentafluorophenyl)boron, and dimethylanilinium tetrakis(pentafluorophenyl)boron. Research is continuing on other co-catalyst systems or the possibility of minimizing or even eliminating the alkylaluminums because of handling and product contamination issues. The important point is that the metallocene catalyst be activated or ionized to a cationic form for reaction with the monomer(s) to be polymerized.

As previously indicated, the nonwoven material of this invention has a basis weight in the range of about 8 gsm to about 200 gsm and the hollow polymer fibers used to

form the nonwoven web material have an outside diameter in the range of about 7 microns to about 50 microns. It will often be most desirable to produce a hollow polymer fiber having as large a lumen volume as possible. It will be apparent to those skilled in the art that certain limitations exist due to physical constraints which limit the volume of the lumen within the hollow polymer fiber. In accordance with one preferred embodiment of this invention, the lumen of the hollow polymer fiber comprises in the range of about 10% to about 60% by volume of the hollow polymer fibers. In accordance with a particularly preferred embodiment, the lumen comprises in the range of about 30% to about 60% by volume of the hollow polymer fibers.

Nonwoven web materials made of hollow polymer fibers in accordance with this invention are suitable for use as a liquid distribution layer and/or surge management material in personal care absorbent articles, which usage requires that the material be able to handle multiple insults.

Materials produced using the hollow polymer fibers in accordance with this invention may be subjected to treatments which provide the fibers with desired characteristics for a particular application. For example, hollow polymer fibers produced from polypropylene, may be rendered hydrophilic by treatment with any number of surfactants known to those skilled in the art.

Nonwoven materials comprising hollow polymer fibers in accordance with this invention may often need to be bonded in order to provide integrity to the web, and optionally further bonded to provide added strength, depending upon the application. For nonwoven materials comprising polypropylene hollow fibers, thermal point bonding is

preferred. Nonwoven materials employing bicomponent fibers in accordance with this invention may be bonded either by thermal point bonding or through-air bonding.

The following examples provide comparisons between spunbond materials made from solid round fibers and spunbond materials made from hollow polymer fibers of equivalent diameter in accordance with this invention. Each material analysis included an evaluation of five specimens. The average value for each material is represented in the tables hereinbelow. The data collected for each material included the following:

Grab Tensile: Cross direction (CD) Peak Load
Machine direction (MD) Peak Load
Cup Crush: Energy (gm/mm)
Load (gm)
Bulk (in) (Thickness) under 0.05 psig load
Air permeability (cfm/sf)
Hydrohead (mbars)
Opacity (%)

CD and MD peak loads are a measure of the strength of the material being evaluated; as such, the higher the peak load values, the stronger is the material. Cup crush, as previously stated, is a measure of the softness of the material being evaluated. In this case, lower cup crush values correspond to softer materials. Although it will be apparent that, with respect to fluid intake, higher material bulk is typically desirable, the values for hydrohead (resistance to fluid flow), air permeability and opacity are of significance primarily in connection with the material application.

Example 1

In order to compare materials of the same strength, a nonwoven material comprising solid round spunbond fibers and having a basis weight of about 17 gsm was selected. Spunbond fiber webs utilized in these examples were thermally point bonded. The

basis weight equivalent for a nonwoven material comprising hollow spunbond fibers was determined to be about 12 gsm. As shown in Table 1, the fiber diameter for the solid round spunbond fibers was 14.4 microns while the fiber diameter for the hollow spunbond fibers was 16.5 microns. The fiber denier were the same for both the solid round spunbond fibers and the hollow spunbond fibers. Although nonwoven materials made from hollow spunbond fibers in accordance with this invention have a substantially lower basis weight than the nonwoven materials made from equivalent diameter solid round fibers, the data show that the CD and MD loads for both materials are the same. The data further show that the hollow fiber material has an air permeability almost twice that of the solid fiber material and a bulk 50% greater than the bulk of the solid fiber material. The data also show that the hollow fiber material is softer than the solid round fiber material based upon the results of the cup crush test.

Table 1

Property	17.0 gsm Solid	12.0 gsm Hollow
Fiber Denier	1.4	1.4
Fiber Diameter (microns)	14.4	16.5
CD Load (lbs)	6	6
MD Load (lbs)	7	7
Cup Crush (grams)	40	30
Hydrohead (mbars)	7.5	3
Air permeability (cfm/sf)	500	900
Opacity (%)	33	23
Bulk (inches)	0.006	0.009

Example 2

Table 2 sets forth the results of a comparison of a nonwoven material comprising solid round spunbond fibers and having a basis weight of about 17 gsm with a nonwoven material comprising hollow spunbond fibers and having the same basis weight,

i.e. 17 gsm and a nonwoven material comprising hollow spunbond fibers and having a basis weight of 14 gsm . The respective fiber diameters were the same as in Example 1. As between the two 17 gsm basis weight nonwoven materials of this example, the CD and MD peak loads for the hollow fiber material were higher than for the solid round fiber material. Air permeability for the hollow fiber material was greater than for the solid round fiber material - 620 cfm/sf versus 557 cfm/sf. CD and MD peak loads for the 14 gsm basis weight material are comparable to the CD and MD peak loads for the 17 gsm solid round fiber material and air permeability is substantially greater than for the solid round fiber material.

Table 2

Properties	17.0 gsm Solid	14.0 gsm Hollow	17.0 gsm Hollow
Fiber Denier Fiber Diameter microns Basis Wt (gsm) Bulk (in)	1.4 14.4 17.0 0.007	1.4 16.5 14.0 0.009	1.4 16.5 17.0 0.011
CD Tensile (lb) Peak Load (lb)	6.3	6.4	8.7
MD Tensile (lb) Peak Load (lb)	8.3	8.2	11.8
Opacity (%)	35.8	23.3	32.0
Cup Crush Energy (gm-mm) Load (gm)	 835 45.2	 551 28.4	 1054 50.2
Air permeability (cfm/sf)	557	891	620
Hydrohead (mbars)	8.2	3.5	6.9

Example 3

A solid round fiber spunbond material and a hollow fiber spunbond material produced from fibers having a fiber diameter of about 24.5 microns and having a basis weight of 173 gsm and a fabric or material density of 0.016 g/cc were prepared and subjected to multiple insult simulation tests. As shown in Table 3, the hollow polymer fiber material is able to hold onto more fluid after each insult than the solid fiber material, demonstrating improved fluid management properties of the hollow fiber spunbond material over conventional solid fiber spunbond materials.

Table 3

Fiber Type	Solid Round Fiber Spunbond	Hollow Fiber Spunbond
Denier (g/9000 m)	3.8	3.4
Fiber Width (microns)	24.5	24.5
Basis Weight (gsm)	173	173
Fabric Density (g/cc)	0.016	0.016
Saturated Capacity	103.3	117.5
Fluid Held (g/g) - 1st Insult	15.5	17.7
Fluid Held (g/g) - 2nd Insult	15.8	18.0
Fluid Held (g/g) - 3rd Insult	16.2	18.4

As previously stated, hollow polymer fibers comprising a metallocene polypropylene polymer in accordance with this invention typically have a hollow percent in the range of about 30 to 50% higher than hollow fibers made with standard (Ziegler-Natta) polypropylene.

Example 4

In this example, hollow fibers produced using a standard polypropylene polymer (Montell E5D47 PP available from Union Carbide) were compared to hollow fibers produced

using a metallocene polypropylene polymer (Exxon 3854 Met PP, available from Exxon Chemicals). The results indicate that, for fibers of comparable outside diameters (OD) produced under the same conditions, the percentage hollowness of the metallocene polypropylene hollow fibers is greater than the percentage hollowness of the standard polypropylene hollow fibers, in at least one case by more than 60%. As shown in Table 4, the percentage hollowness of the metallocene polypropylene fibers was greater in every case than the percentage hollowness for the corresponding standard polypropylene fibers.

Table 4

	Montell E5D47 PP				Exxon 3854 Met PP			
Manifold pressure (psig)	Fiber Diameter (Microns) I.D.	O.D.	Hollow %	Fiber Denier (g/9000m)	Fiber Diameter (Microns) I.D.	O.D.	Hollow %	Fiber Denier (g/9000m)
430 deg F Melt temperature	0.75 ghm				0.75 ghm			
4	14.7	28.9	26.0	5.2	18.0	29.6	37.1	5.5
5	16.6	28.3	34.6	5.0	16.6	27.2	37.1	4.6
6					16.7	26.7	39.0	4.5
7	12.7	24.2	27.4	3.7				
8	12.1	23.6	26.3	3.5				
9	12.2	22.7	28.9	3.2				
450 deg F Melt temperature	0.65 ghm				0.65 ghm			
4	12.6	25.9	23.7	4.2	16.9	27.7	37.3	4.8
5	11.0	23.5	21.9	3.5	14.8	24.8	35.7	3.9
6	11.3	22.5	25.2	3.2	15.9	27.1	34.1	4.6
450 deg F Melt temperature	0.75 ghm				0.75 ghm			
4	14.2	28.7	24.4	5.2	17.2	30.0	33.1	5.6
5	13.1	26.9	23.9	4.5	16.1	26.6	36.7	4.5
6	13.8	26.3	27.6	4.3	15.2	25.9	34.7	4.2
7	11.5	23.7	23.3	3.5				
8	11.2	22.6	24.6	3.2				

Example 5

In this example, bicomponent polypropylene (PP)/propylene ethylene copolymer (6D43 available from Union Carbide) hollow polymer fibers in accordance with one embodiment of this invention were produced and evaluated as an alternative to standard Ziegler-Natta polypropylene hollow fibers under the same process conditions and spinplate geometries. For fibers produced at a melt temperature of 450°F and a manifold pressure of 9 psig, the percentage hollowness of the bicomponent PP/propylene ethylene copolymer hollow polymer fibers was consistently higher than the standard Ziegler-Natta polypropylene hollow polymer fibers. For example, at a grams per hole per minute (ghm) in the range of 0.7 to 0.9, the percentage hollowness for the bicomponent PP/propylene ethylene copolymer hollow polymer fibers was in the range of about16 to 17% hollow compared to a range of about 9 to about 12% hollow for the standard Ziegler-Natta polypropylene hollow polymer fibers. For bicomponent PP/propylene butylene copolymer (DS4D05 available from Shell Chemical Company) hollow polymer fibers produced under the same conditions, at a ghm of 0.9, the percentage hollowness of the fibers was about 17%.

Test Procedures

Cup Crush

The softness of a nonwoven fabric may be measured according to the "cup crush" test. The cup crush test evaluates fabric stiffness by measuring the peak load or "cup crush" required for a 4.5 cm diameter hemispherically shaped foot to crush a 25 cm by 25 cm piece of fabric shaped into an approximately 6.5 cm diameter by 6.5 cm tall inverted cup while the cup shaped fabric is surrounded by an approximately 6.5 cm diameter cylinder to maintain a uniform deformation of the cup shaped fabric. An average of 10 readings is used.

The foot and the cup are aligned to avoid contact between the cup walls and the foot which could affect the readings. The peak load is measured while the foot is descending at a rate of 40.6 cm/minute and is measured in grams. The cup crush test also yields a value for the total energy required to crush a sample (the "cup crush energy") which is the energy from the start of the test to the peak load point, i.e. the area under the curve formed by the load in grams on one axis and the distance the foot travels in millimeters on the other. Cup crush energy is therefore reported in g-mm. Lower cup crush values indicate a softer laminate. A suitable device for measuring cup crush is a Sintech Tensile Tester and 500g load cell using TESTWORKS Software all of which are available from Sintech, Inc. of Research Triangle Park, NC.

Hydrostatic Pressure Test (Hydrohead)

A measure of the liquid barrier properties of a fabric is the hydrohead test. The hydrohead test determines the height of water or amount of water pressure (in millibars) that the fabric will support before liquid passes therethrough. A fabric with a higher hydrohead reading indicates it has a better barrier to liquid penetration than a fabric with a lower hydrohead. The hydrohead data cited herein was obtained in accord with Federal Test Standard 191A, Method 5514 except modified as noted below. The hydrohead was determined using a hydrostatic head tester available from Marl Enterprises, Inc. of Concord, NC. The specimen is subjected to a standardized water pressure, increased at a constant rate until the first sign of leakage appears on the surface of the fabric in three separate areas. (Leakage at the edge, adjacent to clamps is ignored.) Unsupported materials, such as a thin film or nonwoven, are supported to prevent premature rupture of the specimen.

Tensile Strength

Tensile strength or peak load measures the maximum load (gram force) before the specimen ruptures. A 4 inch by 6 inch sample is placed in a 1 inch by 1 inch rubber coated clamp or jaws and a 1 inch by 2 inch rubber coated clamp or jaws (with the longer dimension being perpendicular to the load) so that the machine direction (i.e. the direction in which the fabric is made) is parallel with the load. The sample is placed in the jaws such that there is a 3 inch gage length. The test can be performed with an 1130 Instron Tensile Tester (available from Instron Corporation of Canton, MA) and utilizes a cross-head speed of 12 inches/minute. The load at rupture is reported in pounds. Peak strain is the percent elongation at peak load.

Air Permeability

This test determines the airflow rate through a specimen for a set area size and pressure. The higher the airflow rate per a given area and pressure, the more open the material is, thus allowing more fluid to pass therethrough. Air permeability was determined using a pressure of 125 Pa (0.5 inch water column) and was reported in cubic feet per minute per square foot. The air permeability data reported herein can be obtained using a TEXTEST FX 3300 air permeability tester.

Basis Weight

The basis weight of a nonwoven material is determined by measuring the mass of a nonwoven web sample, and dividing it by the area covered by the sample.

Multiple Insult Simulation Test

The Multiple Insult Simulation Test (MIST) measures the amount of liquid (saline solution) that is held in a material when a specified volume of the liquid is applied

to the material under specified conditions and was utilized to evaluate the materials of this invention. It also measures the amount of liquid retained in the material after the liquid insulted material is placed in contact with an absorbent material, thereby allowing the liquid to transfer from the test material to the absorbent material. The test procedure involves calibration of a pump to deliver 80 grams of liquid in 4 seconds (average flow rate of 20 grams per second). A liquid collection pan is placed on a lab balance beneath the slit in the bottom of a cradle shaped, non-segmented specimen holder. The balance is then tared. The specimen to be evaluated, 2.5 inches wide and 7 inches long, is placed in the bottom of the cradle over a 2.5 inch wide portion of the slit that is taped to prevent liquid from passing through the part of the slit directly beneath the specimen. The slit in the bottom of the cradle runs across the center of the specimen in the direction of the width of the specimen. The ends of the specimen, in the longer dimension, are elevated above the center of specimen at approximately 60° from horizontal. The specimen is insulted by dispensing 80 grams of liquid at a rate of 20 grams per second directed vertically downward into the center of the specimen from the end of a fluid application wand held about 0.5 inches above the center of the specimen. The mass of the liquid in the collection pan is recorded and the balance tared. The specimen is then removed and placed on a tissue-covered absorbent material. The absorbent material is composed of a mixture of 60% Favor® 870 SAM available from Stockhausen GmbH and 40% wood pulp at a total weight of 500 g/m^2. A 397 gram 2.5 inch by 7 inch plate/weight is placed on top of the specimen to cover the full area of the specimen for 5 minutes. This procedure is then repeated 2 additional times. At least two specimens for each material are tested. The liquid held for each insult divided by the initial weight of

the dry specimen and the liquid retained after each desorption divided by the initial weight of the dry sample are then calculated.

While in the foregoing specification this invention has been described in relation to certain preferred embodiments thereof, and many details have been set forth for purpose of illustration, it will be apparent to those skilled in the art that the invention is susceptible to additional embodiments and that certain of the details described herein can be varied considerably without departing from the basic principles of the invention.

WE CLAIM:

1. A personal care absorbent article comprising:

a hollow polymer fiber nonwoven material comprising a plurality of hollow metallocene polymer fibers and having a basis weight in a range of about 8 gsm to about 200 gsm, said hollow polymer fibers having an outside diameter in a range of about 7 microns to about 50 microns.

2. A personal care absorbent article in accordance with Claim 1, wherein said basis weight of said hollow polymer fiber nonwoven material is in a range of about 10 gsm to about 30 gsm.

3. A personal care absorbent article in accordance with Claim 1, wherein said hollow polymer fibers are one of monocomponent and bicomponent fibers comprising at least two segments.

4. A personal care absorbent article in accordance with Claim 1, wherein said hollow polymer fibers comprise at least one polymer having a molecular weight distribution less than about 3.5.

5. A personal care absorbent article in accordance with Claim 1, wherein said hollow polymer fibers comprise at least one polymer having a polydispersity less than about 3.5.

6. A personal care absorbent article in accordance with Claim 1, wherein said hollow polymer fibers comprise at least one polymer having a polydispersity less than about 3.

7. A personal care absorbent article in accordance with Claim 1, wherein said hollow polymer fibers comprise at least one polymer having a polydispersity less than about 2.5.

8. A personal care absorbent article in accordance with Claim 1, wherein said metallocene polymer is metallocene polypropylene.

9. A personal care absorbent article in accordance with Claim 1, wherein said hollow polymer fiber nonwoven material is a laminate.

10. A personal care absorbent article in accordance with Claim 1, wherein said hollow polymer fibers are bonded.

11. A personal care absorbent article in accordance with Claim 1, wherein said hollow polymer fiber nonwoven material is a spunbond.

12. A personal care absorbent article in accordance with Claim 1, wherein said hollow polymer fiber nonwoven material is a body-side liner.

13. A personal care absorbent article in accordance with Claim 1, wherein said hollow polymer fiber nonwoven material is a surge material.

14. A personal care absorbent article in accordance with Claim 1, wherein a lumen of said hollow metallocene polymer fiber is in a range of about 30% to about 60% by volume of said hollow metallocene polymer fiber.

15. A personal care absorbent article comprising:

a liquid impervious backsheet;

a body-side liner comprising a hollow polymer fiber nonwoven material comprising a plurality of hollow polymer fibers and having a basis weight in a range of about 8 gsm to about 200 gsm, said hollow polymer fibers having an outside diameter in a range of about 7 microns to about 50 microns; and

an absorbent core disposed between said liquid impervious backsheet and said body-side liner.

16. A personal care absorbent article in accordance with Claim 15, wherein said hollow polymer fibers are one of monocomponent and bicomponent fibers having at least two segments.

17. A personal care absorbent article in accordance with Claim 15, wherein said basis weight of said hollow polymer fiber nonwoven material is in a range of about 10 gsm to about 30 gsm.

18. A personal care absorbent article in accordance with Claim 15, wherein said nonwoven material is a spunbond.

19. A personal care absorbent article in accordance with Claim 15, wherein said hollow polymer fibers comprise at least one polymer having a molecular weight distribution less than about 3.5.

20. A personal care absorbent article in accordance with Claim 15, wherein said hollow polymer fibers comprise at least one polymer selected from the group consisting of metallocene polymers, polypropylene, polyethylene, nylon, polyester and combinations thereof.

21. A personal care absorbent article in accordance with Claim 15, wherein said hollow polymer fibers are bicomponent polypropylene/propylene ethylene copolymer fibers.

22. A personal care absorbent article in accordance with Claim 15, wherein said hollow polymer fibers are bicomponent polypropylene/polypropylene plus propylene butylene copolymer fibers.

23. A nonwoven material comprising:

a plurality of spunbond hollow polymer fibers comprising at least one polymer having a polydispersity less than about 3.5 and having a basis weight in a range of about 8 gsm to about 200 gsm, said hollow polymer fibers having an outside diameter in a range of about 7 microns to about 50 microns.

24. A nonwoven material in accordance with Claim 23, wherein said hollow polymer fibers are one of monocomponent and bicomponent fibers having at least two segments.

25. A nonwoven material in accordance with Claim 23, wherein said hollow polymer fibers comprise at least one polymer having a molecular weight distribution less than about 3.5.

26. A nonwoven material in accordance with Claim 23, wherein said polymer is metallocene polypropylene.

27. A nonwoven material in accordance with Claim 23, wherein said hollow polymer fibers comprise at least one polymer having a polydispersity less than about 3.

28. A nonwoven material in accordance with Claim 23, wherein said hollow polymer fibers comprise at least one polymer having a polydispersity less than about 2.5.

29. A nonwoven material in accordance with Claim 23, wherein a lumen of said hollow metallocene polymer fiber is in a range of about 10% to about 60% by volume of said hollow metallocene polymer fiber.

30. A nonwoven material in accordance with Claim 23, wherein a lumen of said hollow metallocene polymer fiber is in a range of about 30% to about 60% by volume of said hollow metallocene polymer fiber.

31. A personal care absorbent article comprising:

a hollow polymer fiber nonwoven material comprising a plurality of hollow polymer fibers comprising a metallocene polymer.

32. A personal care absorbent article in accordance with Claim 31, wherein said metallocene polymer is metallocene polypropylene.

33. A personal care absorbent article in accordance with Claim 31, wherein said hollow polymer fiber nonwoven material has a basis weight in a range of about 8 gsm to about 200 gsm.

34. A personal care absorbent article in accordance with Claim 31, wherein said hollow polymer fibers have an outside diameter in a range of about 7 microns to about 50 microns.

35. A personal care absorbent article in accordance with Claim 31, wherein said hollow polymer fibers are one of monocomponent and bicomponent fibers comprising at least two segments.

36. A personal care absorbent article in accordance with Claim 31 wherein said hollow polymer fiber nonwoven material is a spunbond.

37. A personal care absorbent article in accordance with Claim 31, wherein a lumen of said hollow metallocene polymer fiber is in a range of about 30% to about 60% by volume of said hollow metallocene polymer fiber.

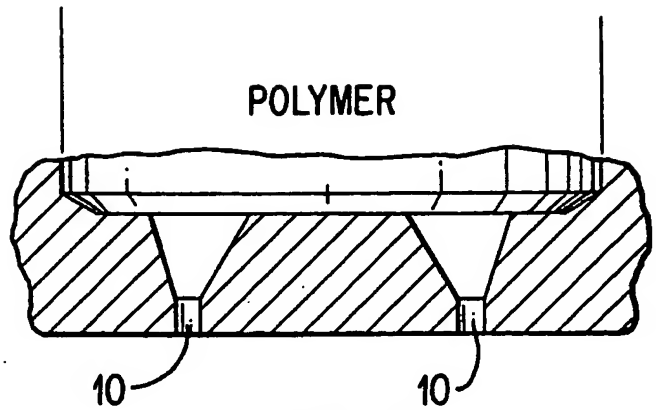

FIG. 1A

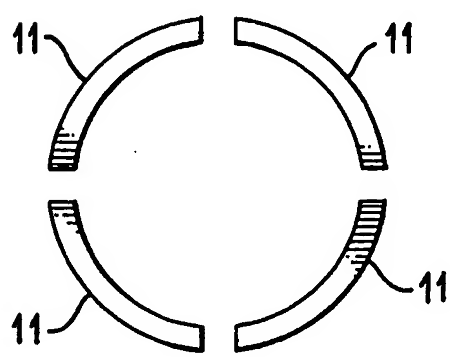

FIG. 1B

INTERNATIONAL SEARCH REPORT

International Application No
PCT/US 00/02077

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 A61L15/24

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 A61L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 97 37065 A (HERCULES INC) 9 October 1997 (1997-10-09) page 1, line 4 - line 29 page 3, line 1 - line 13 page 7, line 34 -page 8, line 27 page 9, line 11 -page 12, line 3 page 11, line 4 - line 8 page 11, line 19 page 11, line 21 - line 36 page 21, line 17 - line 27 page 26, line 5 - line 9 page 37, line 35 -page 38, line 11 claims 94-103; tables 1,8 --- -/--	1-4, 8-13, 15-26, 31-36

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
31 May 2000	09/06/2000

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Cousins-Van Steen, G

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INTERNATIONAL SEARCH REPORT

International Application No
PCT/US 00/02077

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
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INTERNATIONAL SEARCH REPORT

Information on patent family members

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